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MOLYBDENUM

Molybdenum minerals have been found in many places in California, and molybdenum ore has been produced intermittently in the State since 1916. Most of the total output has been a by-product of the Pine Creek tungsten operation in Inyo County and has reflected the activity at this tungsten mine. The most productive period in California was 1941-43 when about 3-3/4 million pounds were produced. During this period California ranked among the first six molybdenum-producing states. Annual production figures for most years are not available, but during 1952 when California ranked fifth as a molybdenum source, the Pine Creek tungsten mine yielded about 300,000 pounds of molybdenum (H.L. McKinley, 1953, personal communication). During 1952 43,259,000 pounds of molybdenum were produced in the United States.

Of all the alloying elements utilized in steel manufacture, molybdenum is the only one in which the United States is self-sufficient. This country's molybdenum resources constitute a larger percentage of known world molybdenum resources than that of any other metal in common use (U.S. Bureau of Mines, 1948, p. 144).

Mineralogy and Geology. Almost all of the world's molybdenum is obtained from the primary mineral molybdenite (MoS_2). Molybdenite is a soft (hardness 1 to 1½), bluish lead-gray mineral with a bluish to greenish-gray streak and a metallic luster. It crystallizes in the hexagonal system, and most commonly occurs as flakes and foliated masses. It can be distinguished from graphite, which it strongly resembles, by the violet color shown in a cleavage crack and by its lighter bluish lead-gray color. Wulfenite ($PbMoO_4$), a minor source of molybdenum, is relatively common in the oxidized zone of some galena- and molybdenite-bearing deposits. Powellite ($Ca(Mo,W)O_4$), an oxidation product of molybdenite, commonly is of little commercial importance, but both tungsten and molybdenum are recovered from it at the Pine Creek mill.

Molybdenite has a wide range of geologic occurrences, but nearly all are genetically related to acidic igneous rocks. Commercial quantities of molybdenite have been recovered from fissure veins, disseminated replacement deposits, contact-metamorphic deposits, and pegmatites. In the world's largest molybdenum deposit at Climax, Colorado, molybdenite occurs with quartz and orthoclase in veinlets within altered portions of a granite mass. Although material containing 0.7 percent MoS_2 was regarded as ore in the early 1930's and the average grade of ore milled had been 0.83 percent MoS_2 (Butler, 1933, p. 231), ore that contains only 5 to 6 pounds of molybdenum (equivalent to 0.5 percent MoS_2) is now being milled (Climax, 1954, p. 5). A mine at Questa, New Mexico, yields molybdenite from quartz veins in granite. Ore from this deposit averages about 5 percent molybdenite (Tyler, 1952, p. 84), an unusually high grade. Disseminated copper deposits of the western United States contain minor amounts of molybdenite. The copper deposits at Bingham, Utah, where molybdenite is recovered as a by-product, have become the world's second largest molybdenum source. The MoS_2 content here ranges from 0.04 to 0.20 percent, and molybdenum can be recovered economically only as a by-product.

Contact-metamorphic deposits, such as those that are worked for tungsten at Pine Creek in California, commonly contain recoverable amounts of molybdenite. Though molybdenite is an accessory mineral in some granites, pegmatities and aplites, it rarely occurs as commercial concentrations in these rocks. Nevertheless, a small portion of the molybdenite mined in California has been obtained from aplite dikes principally in San Diego County.

Some clays and other sedimentary rocks, including the vanadium-bearing phosphatic shales of Idaho Wyoming and Montana, contain molybdenum in proportions ranging from a few hundredths to 0.1 percent (Tyler, 1952, p. 84). Molybdenum possibly could be recovered as a by-product if these materials are processed to recover vanadium.

Localities. At the Pine Creek mine in Inyo County, the tungsten-molybdenum ore bodies occur in a contact zone near the north end and on the west side